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September 1949

UNITED STATES
DEPARTMENT OF THE INTERIOR
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BUREAU OF MINES
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INFORMATION CIRCULAR

OPERATIONS AND SAFETY AT THE RETSOF ROCK SALT MINE

BY

WILLIAM EATHORNE

I. C. 7522,
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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

OPERATIONS AND SAFETY AT THE RETSOF ROCK SALT MINE[1]

By William Eathorne[2]

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7522."

[2] Mining engineer, Bureau of Mines, Health and Safety Division, Albany, N. Y.

INTRODUCTION

Retsof mine, adjoining the village of Retsof, Livingston County, New York, is about 5 miles northwest of Geneseo and 55 miles (air-line distance) due east of Buffalo. It is a single-bed rock-salt mine having extensive horizontal workings as much as 2-1/2 miles long and 1 mile wide and has been in continuous operation since 1885. Retsof mine is the largest producing salt mine in North America and is reputed to be the largest active salt mine in the world.

Retsof is one of three large salt mines operated by the International Salt Co., Scranton, Pa.; T. Forster Courthope is general manager of Retsof and also of the company's Detroit salt mine in Michigan and has held that position for 27 years. He is assisted by Stanley Martin, general superintendent; R. Goetz, maintenance superintendent; and John Riordan, mine superintendent. All are old-timers at Retsof and, according to Courthope, contributed the "lion's share' in bringing the mine to its present standard of safety.

ACKNOWLEDGMENT

This circular was made possible by the generous cooperation of T. Forster Courthope and his assistants, Stanley Martin, R. Goetz, and John Riordan. The information and time generously given are gratefully acknowledged.

GENERAL INFORMATION

The rock salt as mined contains about 99 percent sodium chloride and requires only crushing and screening to prepare it for the market. With the exception of a large jaw crusher underground, all crushing is done in a mill building attached to the headframe of the main hoisting shaft (fig. 1). Five sizes of salt are produced, ranging from about 1/2 inch diameter down to minus seven mesh.

Large quantities of the finished product are used in the manufacture of certain chemicals, explosives, paper, fertilizers, soap, steel, glass, dye setting, water softeners, and for thawing ice. The last use is important in reducing the hazards of falls through slipping and sliding, which makes it a valuable asset in accident prevention.

Contrary to common belief, rock salt is not used in the preparation of table salt, which is produced by evaporation from brine solutions.

About 130 employees underground and 100 on surface produce and process 4,000 to 4,500 tons of rock salt daily at Retsof mine during one 9-hour shift.

HISTORY

Prior to 1884, two men, Foster and Barker, purchased a section of land covering a known salt deposit in an unnamed area in Livingston County, New York. Shortly thereafter, the Retsof Mining Co. was formed, and in all

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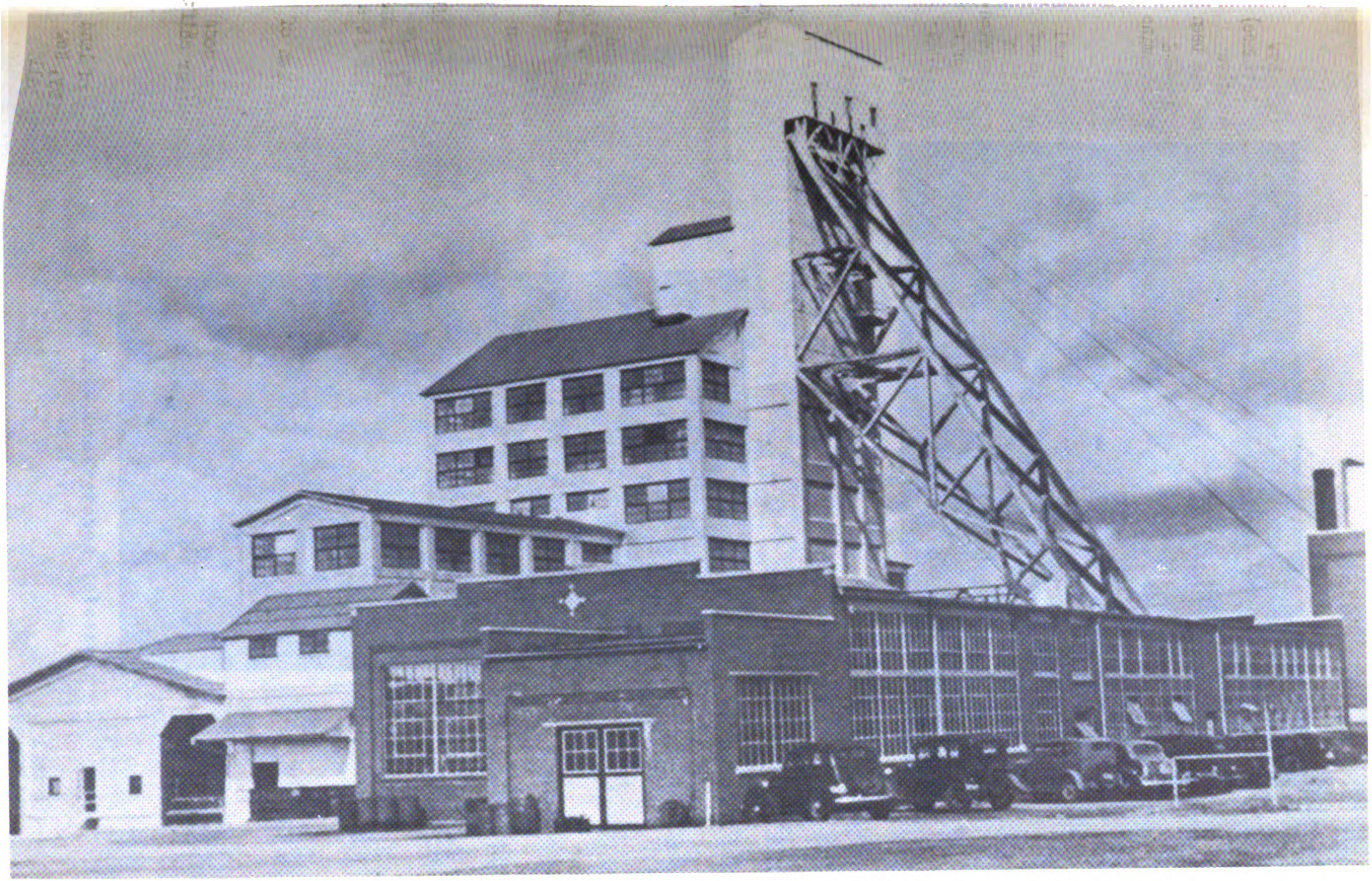

Figure 1. - Headframe and mill building at Retsof's main shaft.

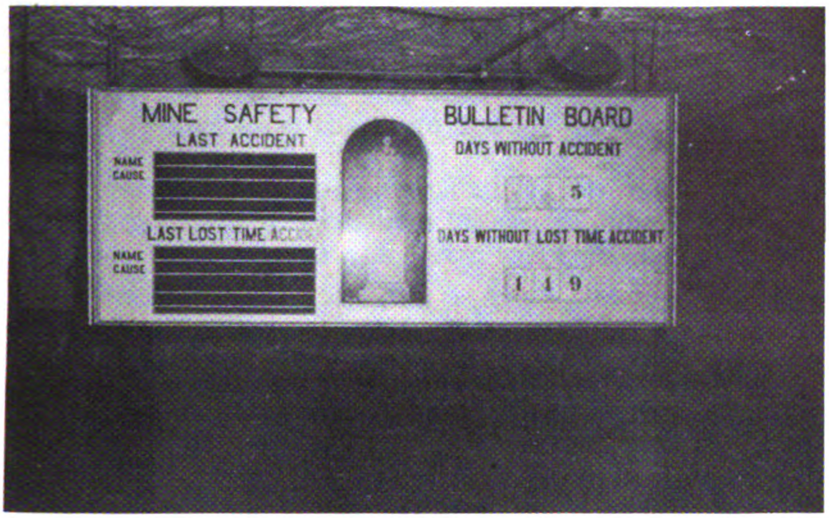

Figure 2. - Safety bulletin board at underground station.

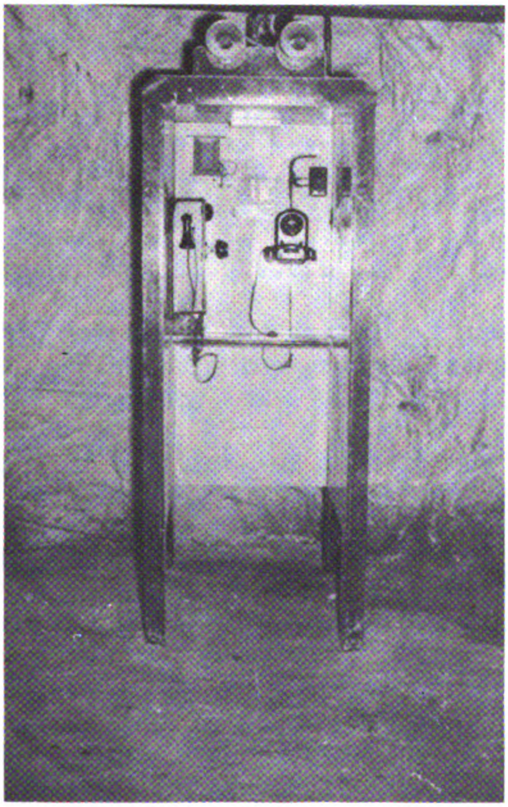

Figure 3. - Underground telephone booth.

probability both men were active in its promotion. The newly formed company sank a vertical shaft over 1,000 feet deep, and the first shipment of salt was made in the autumn of 1885. During this time, or soon thereafter, a village was founded on the property and also was given the name of Retsof, which was originated by spelling the name Foster backward.

In 1895, the Retsof Mining Co. and three other salt producers in the vicinity were consolidated to form a subsidiary of the International Salt Co. Eventually, the Retsof mine became the "star performer," and all the other operations were closed down.

The village of Retsof, a clean, tidy, company-owned community, furnishes housing for about 65 percent of the mine employees; the waiting list for homes indicates that virtually all employees would live there if enough houses were available.

SAFETY RECORD

Retsof's safety record is outstanding. Only one fatality has occurred since the mine was modernized with a new hoisting shaft in December 1923, representing two and one-half decades of operations with only one fatality.

Accident statistics covering the period from January 1, 1929, to September 30, 1948 (only 3 months less than two decades), are as follows:

Man-hours worked.................	6,812,033
Fatalities........................	1
Total lost-time accidents.......	67
Total days lost time............	11,343
Frequency rate....................	11.60
Severity rate.....................	1.83

The 23-year (1925-47) frequency and severity rates covering all entries in the National Safety Competition in the group classed as non-metallic mines were reported recently as: frequency, 32.25 and severity, 6.34.

Retsof was the winner of "Sentinel of Safety" awards in the above competition in 1929, 1931, 1932, and 1933. Furthermore, during those years Retsof created a world's accident record for underground salt mines - 1,090,875 man-hours without a lost-time accident. As far as is known, that record still is unsurpassed. The current safety record is maintained on the safety bulletin board at the main underground shaft station (fig. 2).

A further study of the accident record indicates that war takes its toll in life and injury at home as well as at the fighting fronts. This is probably particularly so in mining because experienced workers cannot be replaced, and increased frequency and severity rates result from the employment of untrained men. If the accident record for the five years 1942-46 (war years and adjustment period following) is eliminated from the two decades covered by the years 1929-48, the astounding record covering the remaining 15 years is: frequency, 5.12 and severity, 0.87. The only fatality occurred in the 1942-46 period.

SHAFT AND HOISTING EQUIPMENT

The present main shaft is about half a mile from the original shaft that was sunk in 1884-85; it is concrete-lined, with parallel sides, circular ends, and 9 by 28 feet over-all dimensions; it was sunk through alternating beds of shale and limestone. The floor of the salt bed is 1,063 feet below the collar, and the total depth of the shaft is about 1,150 feet. The concrete lining ranges from 12 to 18 inches in thickness, with the larger thickness along the sides.

The shaft is divided into three large operating compartments; two are for 12-ton bottom-discharge skips operated in balance and one is for a single-deck, 8- by 6-1/2-foot service or man cage that is operated with a counterbalance and can carry 15 men comfortably. The maximum hoisting speeds adopted for the skips and the cage are 2,000 and 500 feet per minute, respectively. The cage has been provided with regilation safety catches (dogs) to hold it in case of hoisting-rope failure; slack rope drop tests are made monthly to test the effectiveness of the safety catches.

All hoisting ropes are of preformed wire manufactured from high-grade improved plow steel; those for the skips are 1-3/4 inches in diameter, and the cage rope is 1-1/4 inches in diameter. At 6-month intervals, 10 to 12 feet are cut from the shaft end of each rope to provide new connections for the skips and cage and also to provide a new section of rope at the critical zones around the head sheaves, where ropes are subjected to severe impact stresses during the loading periods.

The electrically driven hoists are equipped with Lilly controls, indicators, and hydraulic brakes. An electric signaling system permits the engineer to return all signals received, thus preventing any confusion over intended movements of trips. Should the engineer permit an appreciable amount of slack rope between the sheave wheel and the drum, the rope will contact an electrified wire suspended a few inches from the sheave-wheel rim, and the power will automatically cut off from the hoist.

An electric eye cuts off the skip-hoist power when the head-frame receiving bins are full, thus preventing spillage around the shaft collar.

The head frame is constructed of steel encased in concrete. With the exception of the back braces, the structure, including the sheave wheels, is enclosed with fire-resisting material, and all buildings adjoining the head frame are built of brick or concrete.

Skips, cage, hoisting ropes, hoists, and the shaft compartments are examined every night; ropes are lubricated weekly.

Three other vertical shafts are on the property, and all have served as ventilating shafts from time to time. Two of the shafts are sealed, whereas the third serves as an air intake and also as an emergency exit. The latter shaft is equipped with a good hoist, a large cage, and an up-to-date signaling system, all of which are well-maintained for immediate use in case of emergency. Special precautions have been taken to prevent fire hazards around the collar of this shaft.

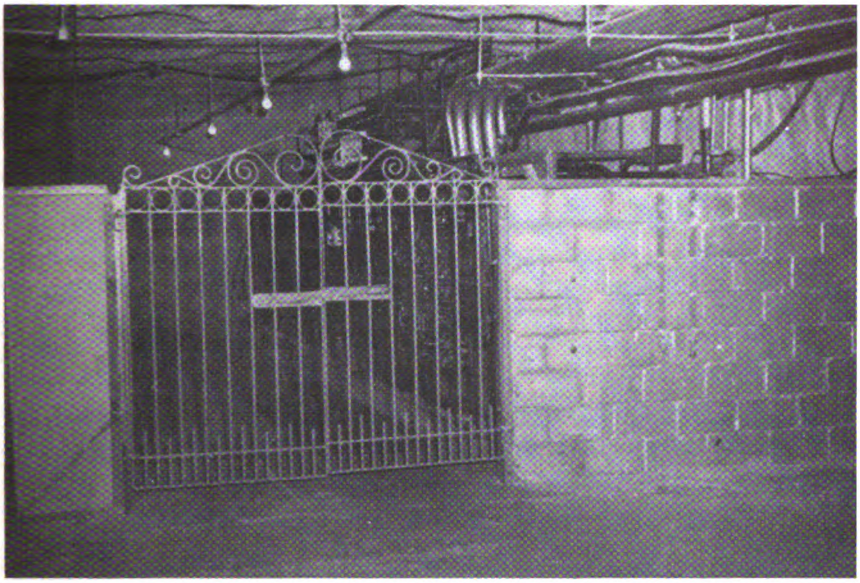

Figure 4. - Underground transformer station.

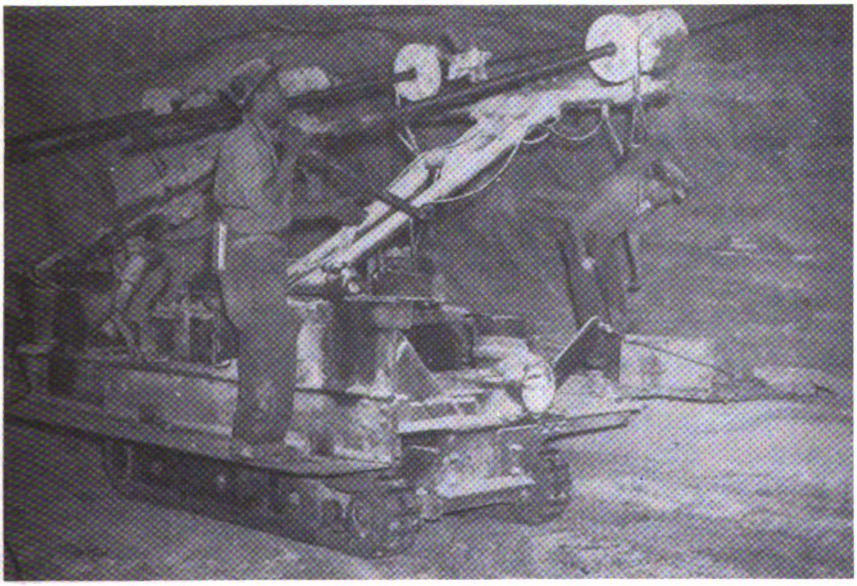

Figure 5. - Drill jumbo.

MAINTENANCE SHOPS

The maintenance shops are underground near the hoisting shaft. The entire shop space has been cut from solid salt and has an area of about 24,000 square feet. Mine tracks, with numerous switches leading to the various sections, are installed throughout the shops, and the entire floor area has been concreted. The machine shop is equipped with excellent modern machines, each with independent drives. Shop lighting is obtained from 114 500-watt bulbs installed on 12- to 14-foot centers and fitted with plastic shades.

A forge in the blacksmith shop is about 200 feet from the main shaft, and gases from it are sucked into a forge hood by a 7-1/2-horsepower, motor-driven fan and are discharged into the shaft through a 12-inch steel vent tube. At the discharge point the gases mix with a large volume of exhaust mine air and thus are rendered harmless.

No repair job is too complicated or difficult for the shops to handle. Various new equipment, ordinarily purchased from manufacturers, has been produced in the shops from time to time; the hydraulically controlled drill Jumbos (used in the mine) were designed and manufactured in these shops.

Telephone service is provided throughout the mine at the shops, shaft station, mine superintendent's office, working stations, blasting stations, and other important points underground (fig. 3) and is maintained in excellent condition. The mine is equipped with about 30 telephones; those at the working sections and blasting stations are provided with horns.

TRANSFORMER STATION

The underground transformer station near the main shaft (fig. 4) is equipped with a bank of transformers containing a synthetic cooling liquid that is nonflammable and nonexplosive. Primary voltage is 2,300, and secondary voltage is 220. The distribution control panels for 220-volt, a.c. power also are in this station.

METHOD OF MINING

The panel-room-and-pillar-method of mining is followed throughout the mine; each panel is about 500 by 2,000 feet. The floor of the salt bed is quite smooth, with a uniform dip of less than 1 percent. Rooms are about 500 feet long (determined by panel width), 55 feet wide, and 9 feet high. Pillars, about 60 feet wide and with alternating lengths of 220 and 185 feet are developed by staggering the crosscuts between rooms. The crosscuts are 55 feet wide, 9 feet high, and 60 feet long and can be considered as small rooms. The method of mining permits about 63 percent extraction, 37 percent remaining in the pillars. Pillar recovery has not been attempted. No subsidence of the surface is apparent immediately over the mined area, which now comprises more than 1,000 acres.

It is essential that salt be mined clean; therefore, no attempt is made to remove the entire thickness of the bed. Virtually pure salt from a few inches to a foot in thickness is left at the roof and floor to prevent contamination of the mined product with the low-grade salt immediately above and below the mineable product. The immediate roof, consisting of pure salt and several feet of impure salt adjacent to it, provides a strong, safe mine roof. The roof in the large rooms does not require artificial support; injuries from falls of roof are infrequent.

The first step in advancing the face of a room is to cut a horizontal kerf in the salt 6 inches high and 10 feet deep, extending from wall to wall at the floor. This is done with an undercutting machine that receives its power through a trailing cable; a 2-man crew operates the machine. Eight such machines are in use; they are transported from room to room on a track-mounted carrier equipped with an adjustable platform that serves as a ramp. A cable reel truck equipped with a mechanical cable reeler is attached to the carrier.

The next step is to make two vertical (shear) cuts in the face from the floor to the roof, one at each of the side walls; these cuts also are 6 inches by 10 feet. The vertical cuts are made with a shearing machine that receives electric power through a trailing cable and is operated by a 2-man crew. The two shear cuts can be made in less than one third the time required for undercutting; therefore, two shearing machines are enough to follow the eight undercutters. Each shearing machine is equipped with a mechanical cable reeler.

Drilling is the third operations and follows shearing of the face. This is done with four electric drilling machines with auger-type drill steel mounted on a company-built "Jumbo" (fig. 5) equipped with caterpillar treads and operated by electric power. A trailing cable for the jumbo is conveniently handled by a built-in mechanical reeler. The drilling machines are mounted about 4 feet 6 inches apart, horizontally, to conform with the standard spacing between holes. Finger-tip control by means of a hydraulic mechanism makes it possible to set a unit of two machines to any height and inclination between the floor and the roof. Built-in floodlights are provided. A "jumbo" complete with drills and drill steel can be moved from room to room on its caterpillar treads; however, the usual practice is to transport it on a special track-type carrier. Within 4 minutes after the carrier is spotted for unloading at a point about 40 feet from the face, drilling can be started. Three such machines are in use.

With three settings of the drill jumbo, a round of about 50 holes 10-1/2 feet deep, in 4 horizontal rows, can be drilled in a room 55 feet wide. The entire round can be drilled by a three-man crew in about 2 hours, with two men each operating two drills and the third serving as a helper or attendant; members of the crew alternate in their duties.

Whenever undercutting, shearing, or drilling crews are working in a room, an approved-type derailer is clamped to the track at a convenient distance from the face to prevent a haulage trip or part thereof from running into them inadvertently. All electrical mining equipment operates with 275-volt d. c.

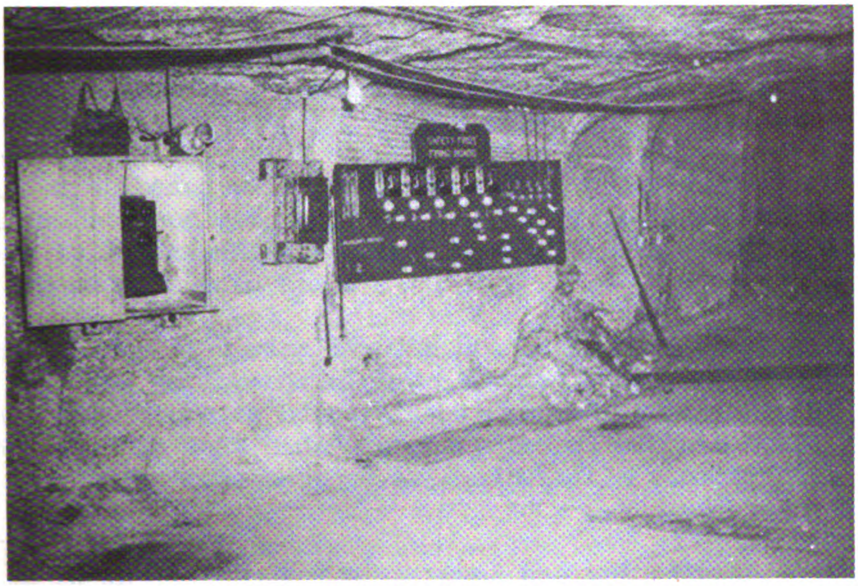

Figure 6. - Panel-type blasting station.

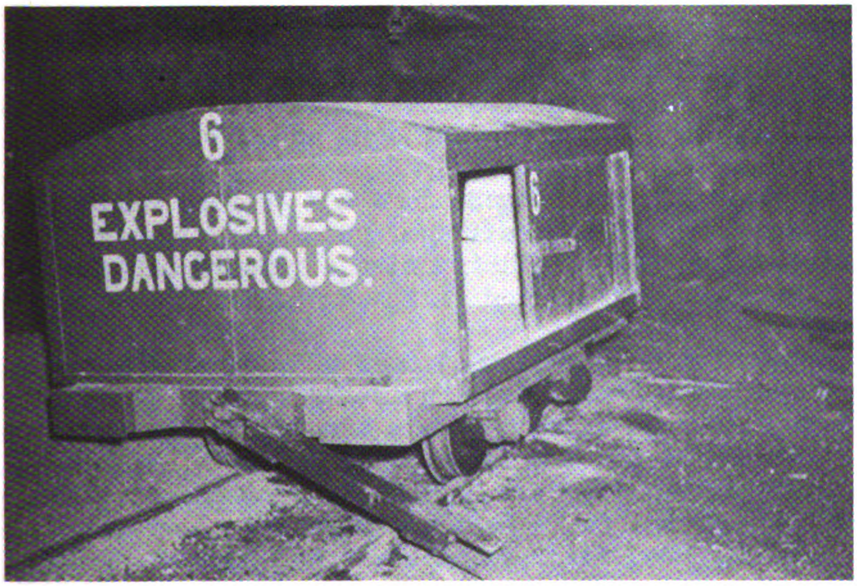

Figure 7. - Explosives car.

BLASTING PRACTICES

All blasting is done by a crew of four men who begin work 1 hour later than the regular shift and quit 1 hour afterward. Preparations for blasting begin as soon as the crew comes on duty, but firing is not done until everyone on the regular shift has left the mine.

Each room must be cleared of all equipment before the blasters charge the blast holes. About 80 rooms are in production, and blasting is done in 12 to 14 of them daily.

All holes are loaded with 1-1/4- by 8-inch cartridges of 25 percent dynamite and are stemmed with salt cuttings from the drilling machines through the use of specially manufactured stemming bags 18 inches in length; two bags of stemming are used in each hole.

Blasting is done electrically with No. 6 aluminum-shell detonators that have bright red- and yellow-enameled coated leg wires. Although the use of aluminum shell detonators is comparatively recent at most mining operations, they have been used in salt mines for many years, because small pieces of copper from copper-shell detonators are undesirable contaminants in rock-salt products.

All holes in the bottom row of a round are primed with instantaneous detonators; 75-millisecond delays are used in the second row, 100-millisecond delays in the third, and 150-millisecond delays in the fourth or top row. Inasmuch as the time interval between delays is small, the fourth row of holes will detonate in about one-seventh of a second after the first row; an entire round sounds like a simultaneous blast to the unaided ear.

Ordinary delay detonators having a time interval ranging from 1 to 3 seconds have proved unsuitable for blasting at Retsof; therefore, after the millisecond delay detonators were developed, they were adopted for the mine and superseded the instantaneous type that previously was used exclusively.

A parallel-series hook-up has been adopted for blasting, in which each row is connected in series, and one leg wire at each outside hole is connected to the parallel-circuit lines. A galvanometer is used for testing the integrity of each series before the final hook-up is completed.

Two lightly insulated No. 20 lead (connecting) wires connect the round at the face with the permanent blasting lines. Lead wires are supported well above the floor, and the outby ends are kept short-circuited until immediately before firing. No. 14 Duplex wiring is used for the permanent blasting lines, which are supported on insulators attached to small wooden plugs driven into holes drilled in the roof; the ends of these wires, generally about 50 feet from the face, also are kept short-circuited until ready to fire.

From 12 to 14 panel-type blasting boards (fig. 6), each holding 6 to 8 safety-blasting switches, are provided at convenient points out of the danger zone of blasting. A telephone and a master switch are adjacent to each panel.

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Connections between a master blasting switch and a panel are made with a duplex jump connector fitted with special plugs; the connector is kept under lock when not in use. All switches are locked in the open position until needed for firing. All blasting circuits are powered with 275-volts d.c.

The rounds are fired after everyone except the blasters and a station attendant has left the mine. Blasters are informed by telephone when they may begin firing.

After the all-clear signal has been received by the four blasters, each of whom is assigned to an area covered by a panel, a telephoned order that the electric power be cut off at surface is given. Power is not turned on again until all the blasters have connected the lead wires to the main blasting lines and have reported by telephone that they are ready to fire. Lights indicate when the power is "on," and with the closing of the necessary switches all blasting rounds in the mine are fired almost simultaneously. An occasional exception to this is when a combination of four panels, covering, in general, 20 to 30 rooms, does not include every room to be blasted. Blasting switches are inspected regularly by two electricians who have been specially assigned to maintain them properly.

All explosives are transported in the shaft and throughout the mine in special, scarlet-painted, wood explosives cars (fig. 7) completely enclosed and lined throughout with sheet rubber and provided with insulated couplings. Nine such cars are available; each is 5 feet wide, 8 feet long, and 2-1/2 feet deep.

Before blasting operations proceed in a room, derailers are clamped to the tracks near the entrance thereto and remain there until blasting is completed.

No accidents have occurred from the use of explosives in the last two decades, during which time from 12,000,000 to 15,000,000 tons of salt have been mined.

MUCKING

The broken salt, ranging in size from pieces weighing half a ton to particles of dust, is loaded into 6-1/2 ton-capacity steel cars by caterpillar-mounted shovels having a 360° swing through the range of a 32-foot diameter circle. All have hydro-electric controls and receive 275-volt d. c. power through trailing cables. Secondary blasting is not required to facilitate loading.

A train of three cars is usually loaded as a unit before it is removed to a gathering zone; such a train is moved on a temporary track supported by steel ties in the center of a room. The 3-car trains are hauled with 8-ton, electric, gathering locomotives equipped with trailing cables and mechanically operated reeling drums. Four to six hours are required to muck a room where the average break is about 350 tons.

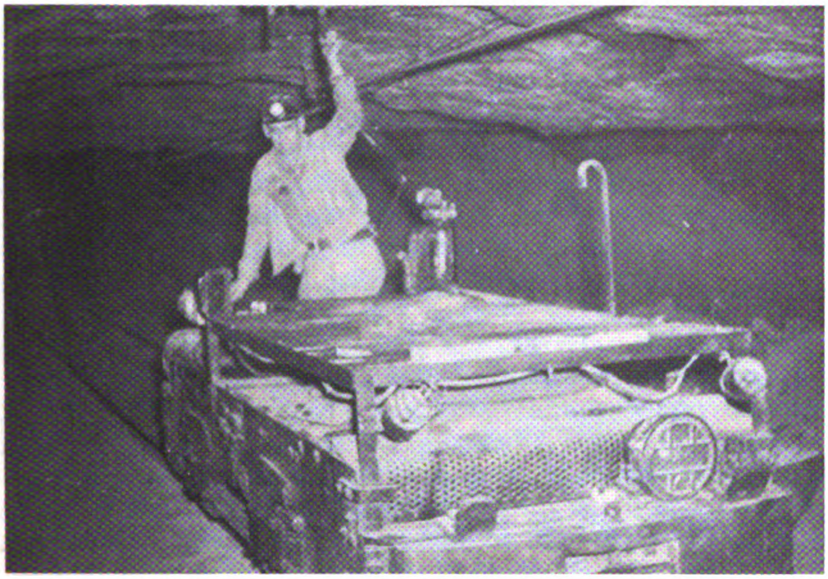

Figure 8. - Overhead tap levers for operating electrically controlled track switches.

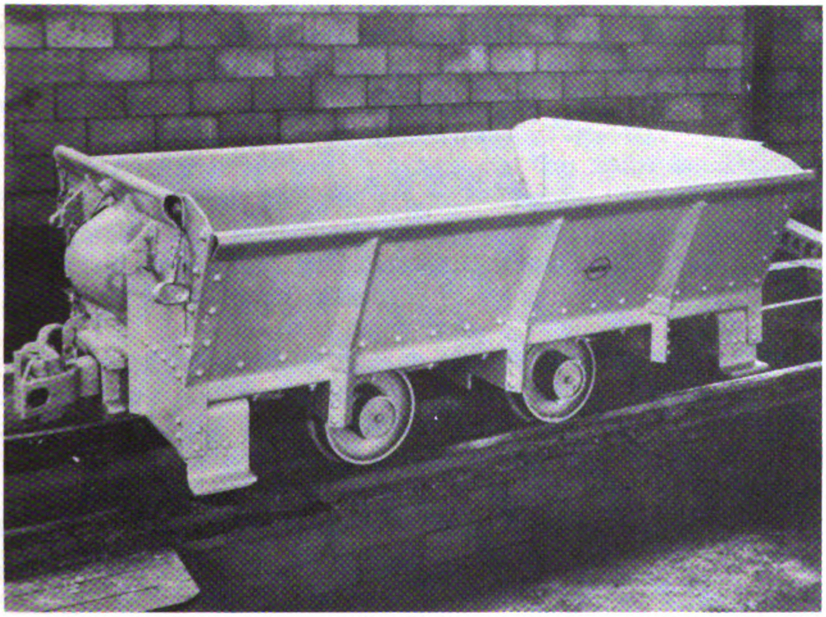

Figure 9. - Mine car, 6½-ton capacity, fitted with automatic couplers.

Eleven shovels and 18 gathering locomotives are available for mucking; usually one but sometimes two locomotives are assigned to a room whenever mucking is in progress.

MAIN HAULAGE

Main-line haulage trains consist of 40 cars, each hauled by two 15-ton trolley locomotives connected in tandem. Six tandem locomotive units are operated; each is equipped with finger-touch-control hydraulic and wheel-type hand brakes. The hydraulic brakes operate through an accumulator, in which a constant pressure of 500 p.s.i. is maintained by means of an electric pump. All locomotives are provided with warning sirens.

Main-line trolley-wire size is 350,000 circular mils supported by clamps on vertical steel rods, which are attached to the roof by expansion shields in holes drilled in the roof. The steel rods are cut and threaded to the exact length required, usually 1 to 2-1/2 feet, depending on the height of roof, so that the trolley wire is supported at a constant distance of 7 feet above the rail. The main-line haulage is more than 2 miles in length, and five generator stations have been provided to minimize voltage drop; 275 volts d.c. is the standard line potential.

Main-line haulage tracks consist of 60-pound rails on a 36-inch gage, secured to 7- by 7-inch wooden ties, which in turn are well-ballasted with rock salt. Derailments at Retsof are rare. All rail joints are welded, and 500,000 circular mil cross bonds are provided every 200 feet.

A block signaling system has been installed on the main haulageways, and all track switches are electrically controlled through the use of tap levers, conveniently secured to the roof at points over the center of the track and within easy reach of the locomotive operators (fig. 8). Automatic switch-type derailers are provided at important points on the main haulageways to derail a train if it should run through a red signal light. Permanent electric lighting is provided throughout the main haulageways, and special attention is given to the lighting at gathering stations and switches. All main haulageways are approximately 30 feet wide and 9 feet high.

New-type mine cars specially designed for Retsof are now being installed; 150 of them are in use, and an equal number will be delivered later. Each car has a capacity of 6-1/2 tons of rock salt and is fitted with automatic couplers (fig. 9). Such a coupler is released by pulling an ingeneously installed steel cable that can be operated by a man standing entirely clear of a car. The cars were designed and developed through the cooperation of Retsof personnel and the manufacturer.

Locomotives are painted bright yellow, and the same color was adopted for the new cars for good underground visibility.

When a loaded train arrives at the shaft station, the locomotive unit is detached and returns to the producing area immediately with a trip of empty cars. Loaded cars are dumped by a mechanically operated rotary car dumper, one car at a time being handled without uncoupling the individual cars in a train. Cars are fed into the dumper by an electrically operated reciprocating feeder. Each car, when dumped and righted, moves forward clear of the dumper and is replaced by the next loaded car until all loaded cars are dumped and passed to the empty tracks on the other side of the station. The lay-out of tracks in the vicinity of the dumping station includes two loop systems (fig. 10). Overhead steel bridges for workers who must cross the mine tracks are provided as shown in figure 11.

After dumping, the rock salt passes over grizzley bars with 8-inch openings the "fines" drop into a divided skip pocket, and the oversize passes to a jaw crusher with an 8-inch discharge opening. The crushed oversize joins the fines in the divided skip pocket and becomes ready for transfer into two cartridge-type skip loaders. Skip loading is controlled by an operator on the station and not by skip men working at the bottom of the skip pocket, as is frequently done at many underground operations.

VENTILATION

Intake air enters the mine through the air-emergency shaft and is coursed to the working sections, assisted by bratticing the mined-out panels with walls built of rock salt. Mechanical ventilation is provided to insure an ample volume of air through the workings; a large fan installed near the dumping station at the main shaft serves this purpose. The fan exhausts air from the workings and discharges it into the main shaft at a pressure of one-half inch water gage, making this an upcast shaft. This is a well-installed, nonreversible, variable-pitch, propeller fan having a maximum capacity of 200,000 cubic feet of air per minute (fig. 12); at the present time it handles 140,000 cubic feet per minute. Power is furnished by a 75-horsepower, 2,200-volt, alternating-current motor with a V-belt drive. A stand-by fan of 100,000 cubic feet capacity is provided; it is a reversible propeller-type fan driven by a 50-horsepower, 2,200-volt, alternating-current motor. Each fan is well installed in an offset, and both are well-maintained. Remote controls were not provided when the fans were installed, but this important item is now being given serious consideration.

Short circuiting of the air flow is prevented on the main haulageways by the presence of automatic ventilation doors (fig. 13) erected at strategic locations. The block-signal system previously described safeguards the possibility of collisions at the doors.

The method of ventilation is simple and efficient. Temperature throughou the accessible workings is virtually constant throughout the year at 61° F., and relative humidity averages 58 percent. More than a 3-degree variation in the wet- or dry-bulb temperature at Retsof is considered abnormal.

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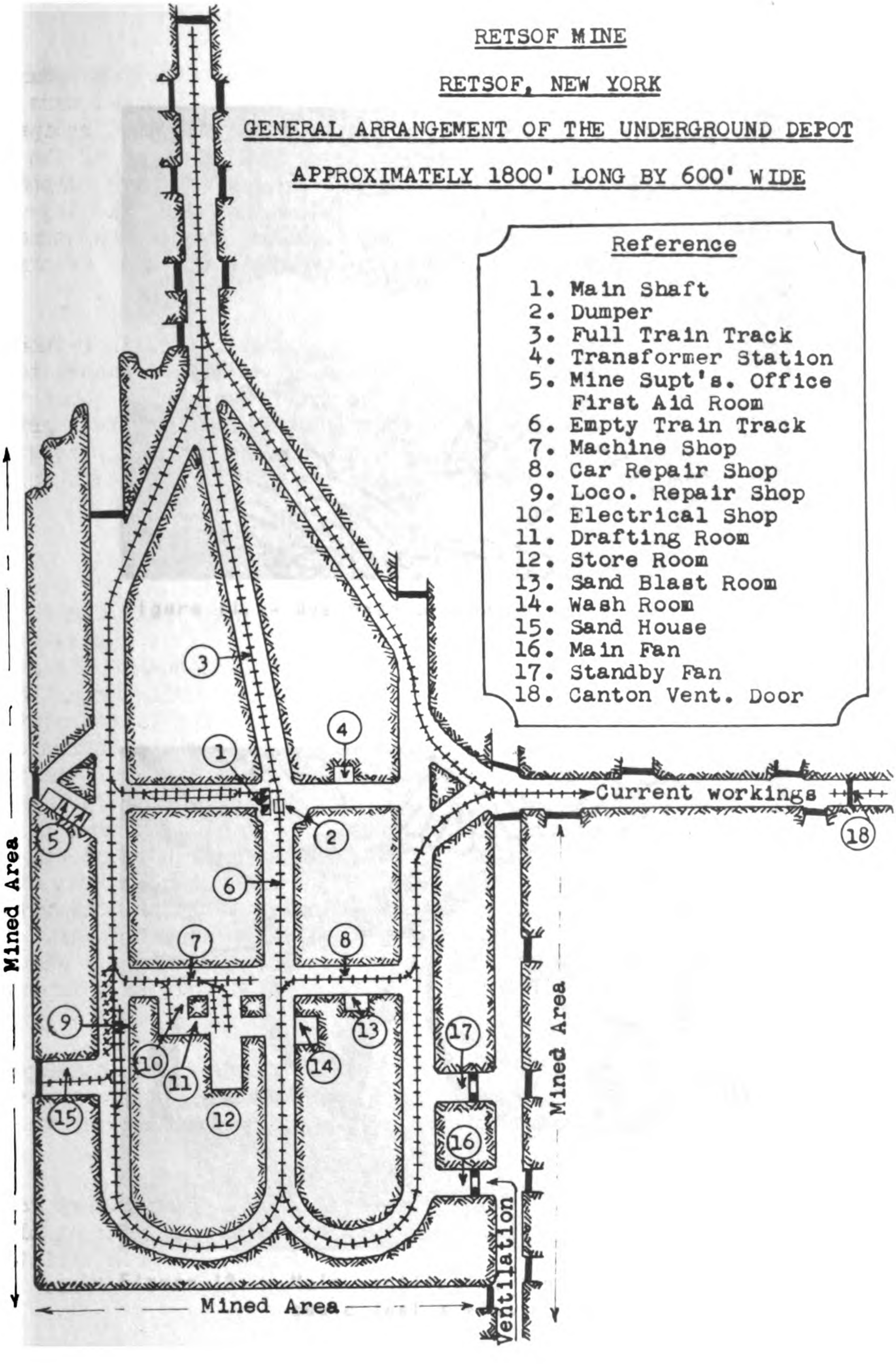

RETSOF MINE

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GENERAL ARRANGEMENT OF THE UNDERGROUND DEPOT

APPROXIMATELY 1800' LONG BY 600' WIDE

Reference

1. Main Shaft
2. Dumper
3. Full Train Track
4. Transformer Station
5. Mine Supt's. Office
   First Aid Room
6. Empty Train Track
7. Machine Shop
8. Car Repair Shop
9. Loco. Repair Shop
10. Electrical Shop
11. Drafting Room
12. Store Room
13. Sand Blast Room
14. Wash Room
15. Sand House
16. Main Fan
17. Standby Fan
18. Canton Vent. Door

Figure 10.

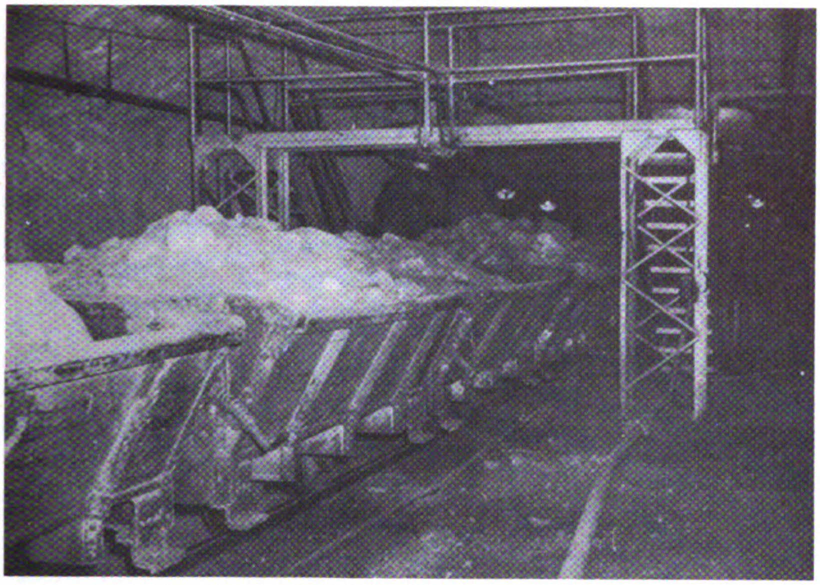

Figure 11. - Overhead bridge spanning mine tracks.

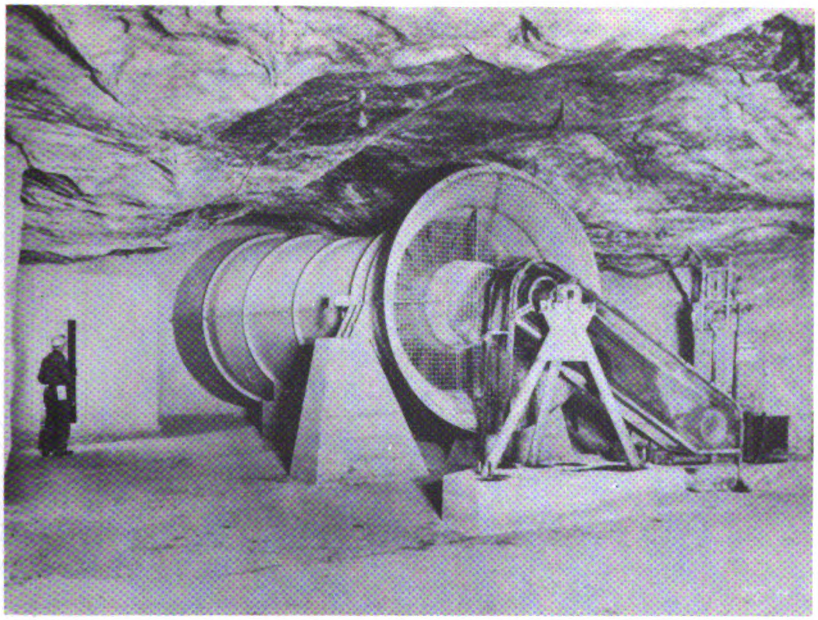

Figure 12. - Main ventilating fan, capacity 200,000 cubic feet a minute.

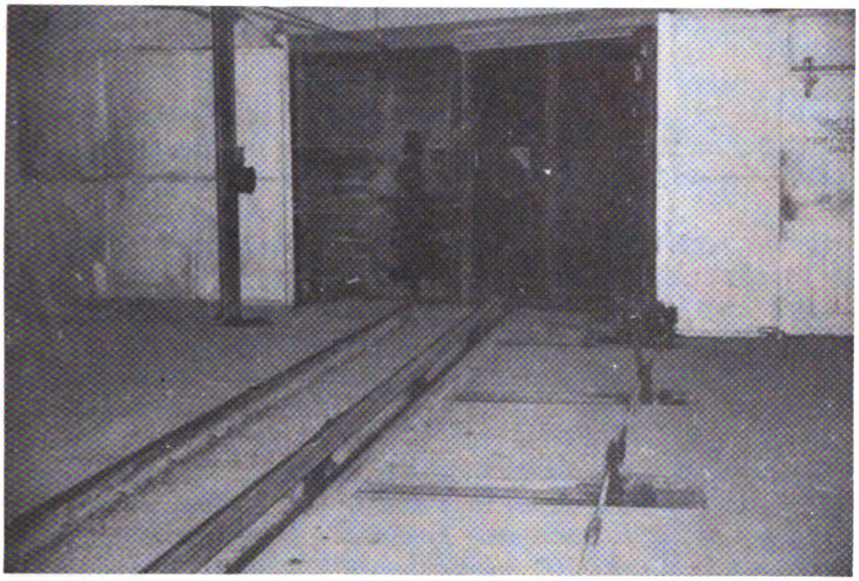

Figure 13. - Automatically controlled ventilation door.

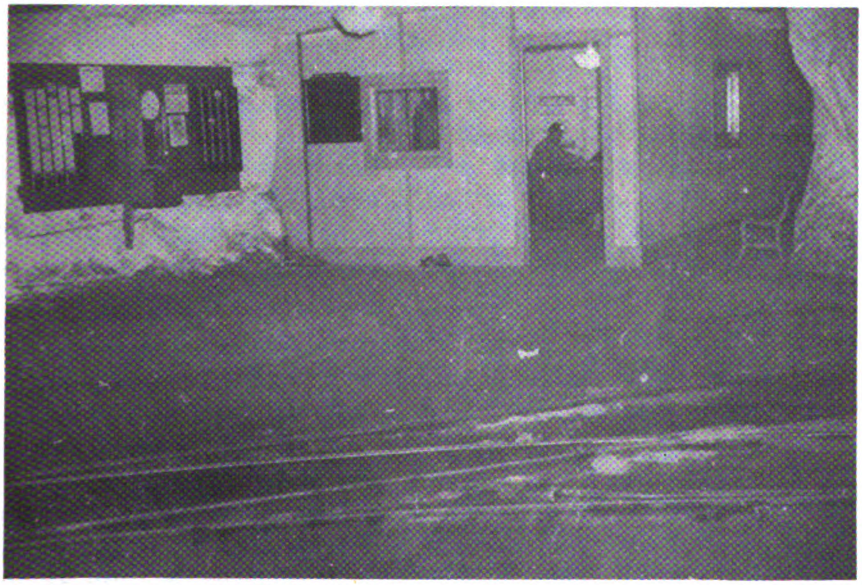

Figure 14. - Mine superintendent's underground office.

HEALTH AND SAFETY FACILITIES

The company employs a full-time safety engineer, and daily inspections are made in the interest of health and safety. The safety engineer keeps the accident records, also and investigates every injury, regardless of its magnitude.

Inspections are made about four times a year, also, by a New York State mine and explosives inspector. Insurance company representatives also inspect both surface and underground operations from time to time.

A general safety committee consisting of about 25 supervisors and keymen controls all company matters pertaining to health and safety. Once a month a 5- man committee inspection is made; it is customary to rotate members of the general safety committee in assignments to an inspection committee. In addition, a workman's safety committee functions independently of the general committee.

With the exception of three months in summer, the company sponsors a monthly dinner-safety meeting for members of both committees. This meeting is generally presided over by the general manager; with the general superintendent as alternate chairman. Immediately following the dinner, a thorough discussion ensues of all accidents that have occurred since the previous meeting. Accidents without lost time receive as much attention as those with lost time. Responsibility for each accident is determined, if possible, and recommendations are made for preventing future similar occurrences. All new safety rules or amendments of old rules must be approved by the general safety committee before becoming effective; this is done at one of the dinner-safety meetings, as circumstances warrant.

The safety program includes first-aid and mine rescue training and sampling and analysis of mine air. Two first-aid rooms are available, one at surface and the other underground. The former is equipped with a cot, inhalator, stretcher, and a complete line of first-air supplies, whereas the latter has similar equipment, with the exception of an inhalator. Both first-aid rooms are maintained at standards equal to good hospital practice.

Three self-generating, oxygen-breathing apparatuses are available, and 15 universal type gas masks are provided and maintained ready for immediate use. This equipment is kept on the surface and at the underground office of the mine superintendent (fig. 14).

Small amounts of methane, up to 0.06 percent, have been detected in the mine atmosphere. Notwithstanding the small percentage of methane that has been detected, a permissible-type combustible gas detector and flame safety lamps are used continuously to search for the presence of methane. When present, the gas invariably originates from a badly broken floor and not from the salt bed.

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Hard hats and hard-toe shoes are worn by all underground employees, and electric cap lamps are provided for all who work in the mine beyond the shaft station area. Safety goggles are provided for all men exposed to eye hazards.

Wash rooms are provided near the underground shaft station and are fitted with flush toilets and urinals. These installations are maintained in excellent condition and compare favorably with similar facilities in well-regulated public buildings. Disposal from the wash rooms goes to septic tanks, from which the overflow passes to a sump and is pumped to the surface with the mine water.

Housekeeping throughout the mine is outstanding.

Very little water can be observed in the mine; virtually all of it is from shaft seepage and amounts to about 350 gallons an hour. Small pumps at shaft stations deliver water to a common sump, from which it is then pumped to the surface under a pressure of 500 pounds per square inch. About 20 hours of pumping will dispose of a week's accumulation of water.

CONCLUSIONS

During the past 25 years a persistent effort has been made to devise and develop better conditions for the health and safety of employees. The blasting technique and the new mine cars described are both recent major developments. Yellow trailing cables for all mobile equipment will be adopted in the near future.

Retsof did not just happen. It is true, "Mother Nature" was good when she prepared and mixed the ingredients that form the product of this mine, but it was the ingenuity of man that made this an outstanding operation.